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The use of quality assurance phantoms to measure variations In image quality

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Abstract: The work aimed to measure and to evaluate the quality parameters of computed tomography image at precise slice thickness. This study examined the image quality tests by using two different quality assurance phantoms to ensure the image quality status besides examining the capability of phantoms to perform these tests.

The imaging quality of multi detector Computed tomography (CT) scanner Brilliance 64, Philips was evaluated using two phantoms. The scanner was tested in the same day. The same protocol parameters of Philips phantom were used on both phantoms. Computed tomography (CT) images which we obtained for each module were analyzed.

The image quality parameters of each resulted module were obtained. The tested parameters were compared for each phantom. It was found as follow: positioning, alignment, slice thickness, high contrast resolution, and uniformity tests were accepted values and within tolerance levels in both phantoms. While noise, test was out of the tolerance values in both phantoms. There was a good capability of recognizing artifacts in both phantoms and there were two types of errors recorded: A ring artifact and a strike artifact. Ring artifacts are very common artifacts generated by detectors. CT number test results were accepted in ACR phantom but in Philips phantom there was two materials out of tolerance values.

The quality assurance phantoms are very important devices for radiology and medical field. It improves the image quality of the CT scanners. It was concluded that; the use of two different types of those phantoms has confirmed the status of the image quality and that; the American College of Radiology (ACR) phantom is a suitable choice to evaluate advanced quality assurance tests specially those tests of precise slice thickness. ACR phantom is much easier than manufacture water phantom in positioning test so it takes less effort and less time.

keywords: CT - Phantoms - precise thickness –QC

1. Introduction

Computed tomography (CT) has been widely applied as a vital non-invasive diagnostic tool in the medical field. CT has also been proven to be accurate in demonstrating anatomy and pathology due to its precise spatial resolution [1, 2]. CT is utilized extensively in imaging of the head. CT is sufficient and diagnostic in many clinical circumstances such as acute trauma, non-traumatic intracranial hemorrhage; also CT is useful screening tool for indications such as mental status changes, acute neurologic deficit, and acute headache. CT is very useful screening modality for the presence of neoplasm and mass effect to which the addition of intravenous contrast may provide added sensitivity in selected circumstances [3]. Achieving high quality imaging will also minimize the radiation exposure.

The advanced quality assurance checks which have been tested in our study are the resolution test, tomographic section thickness measurements. The manufacture manual protocol of checking the 64 x 0.625was used. This precise measurement of small slice width provides us to evaluate the consistency of image. But according to manufacture advice another phantom should be used for achieving more precise measurements. So two phantoms were used (manufacture phantom and an American College of Radiology ACR phantom) [4].In our study we could measure the variations in image quality consistency and evaluate wither it meet with baseline values and tolerance of each phantom or not .The DICOM (Digital Imaging and in Communications Medicine) viewer program software was used for analyzing our data Since it has well-developed image quality checks and tolerances for standard CT systems [5, 6]. DICOM also is relatively simple to set up. The American College of Radiology (ACR) CT accreditation phantom (Gammex-464) was established on the highest radiation safety levels and showing the fundamentals [7, 8]. The IAEA (International Atomic Energy Agency) recommends acceptance tests and periodically quality assurance tests of CT-scanners with respect to radiation dose and image quality [9]. Our objective was to measure the variations in image quality and evaluate it using two quality assurance phantoms.

2. Materials

2.1. CT scanner

A multi-detector computed tomography scanner was used in this study. The model of the scanner is:(Brilliance64, Philips Medical System, Eindhoven; the Netherlands).

2.2. Manufacture head phantom

The Philips phantom is in two parts: a head phantom part and a body phantom one as Figure 1 (a) shows. Due to its simple design this phantom is suitable for quick image quality test (CT number, CT uniformity, CT noise and low contrast resolution). A PVC (Polly Vinyl Chloride) shell filled with water operates as the head phantom. It has a diameter of 200 mm and is composed of three layers. Tests of advanced quality assurance these protocols can be important in solving issues that are discovered during the everyday and monthly Checks. They're developed for Physicist and the Philips Service Specialist to use as advanced applications [10]. Physics layer as shown in Figure 1(b) represent module 1 use for evaluating resolution test and tomographic section thickness (slice width) measurements. Water layer as shown in Figure 1(c) represent Module2 used for noise test. Multi-pi n layer as shown in Figure 1(d) represent Module 3 used for checking contrast scale. Phantom composition according to the Figures below: The 1**st** layer **1** is the Physics Layer including 2: Aluminum strips inserted at a 45° angle. **3**: Is 0.18 mm copper wire for measuring impulse response**. 4:** is the water layer. **5:** is a multi-pin layer includes **6**: Nylon (Aculon) body with Lexan pins measuring (3, 4, 5, 6, 7, and 8) mm respectively. Pin **7:** made of Lexan. (Pin **8** & **9)** are made of Acrylic.

Were **9:** consists of seven rows of different-sized holes.(Row 1: 1.00 mm holes, 2.00 mm apart & Row 2: 1.25 mm holes, 2.50 mm apart & Row 3: 1.50 mm holes, 3.00 mm apart & Row 4: 1.75 mm holes, 3.50 mm apart & Row 5: 2.00 mm holes, 4.00 mm apart & Row 6: 2.50 mm holes, 5.00 mm apart & Row 7: 3.00 mm holes, 6.00 mm apart). **10**: Teflon pin. **11**: Polyethylene pin

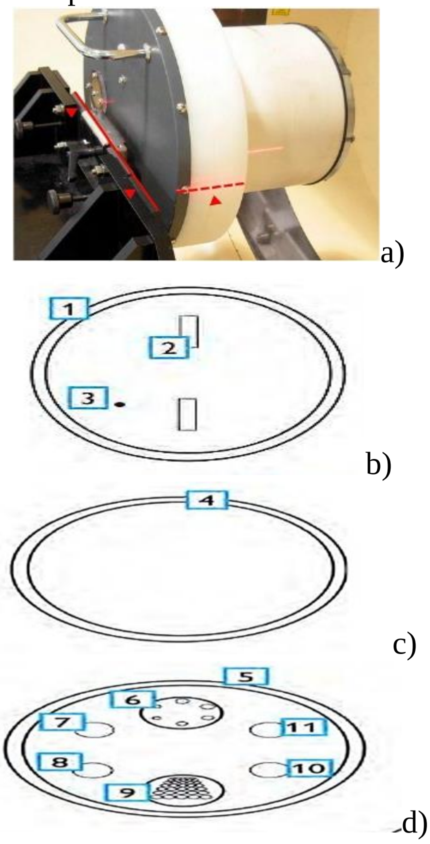


Figure 1

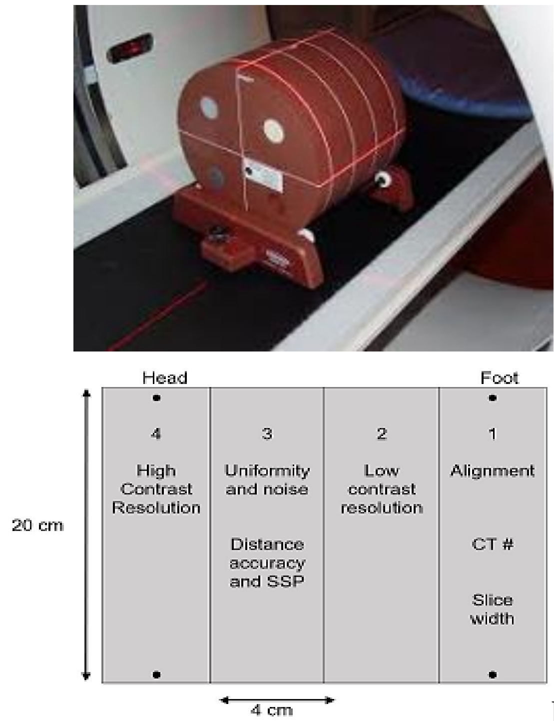
Figure 1(a) Present a picture of a Philips phantom that has been properly aligned and is oriented vertical with laser markers over the edge of the metal plate on the phantom holder. **(b)** First module **1** Physics Layer. **2**: Aluminum strips inserted at a 45° angle while **3**: 0.18 mm copper wire for measuring impulse response. **(c)** Second module which indicated with **4**: A Water Layer. **(d)** Represents **5**: The third module of multi-pin layer including (**6**: Nylon (Aculon) pin, **7**: Lexan pin, while **(8 &9)** are Acrylic pin, **10**: Teflon pin, and **11**: Polyethylene pin)

2.3. American college of radiology (ACR) phantom

The ACR CT accreditation phantom is made up of four sections that are used to test the required image quality parameters [11, 1].

It's a solid phantom made out of a water-equivalent substance, just as in Figure2 (a). This phantom's solid water structure makes it a physically stable tool that produces consistent results over time. Each module has a depth of 4 cm and a diameter of 20 cm. [12]. External x, y, and z axis alignment are visible Marks that are lined and painted white (to reflect the straightening light) at each slice to facilitate phantom reflection on the axial axis (z axis, cranial/caudal), sagittal (x axis, left/right), and coronal (y axis, anterior/posterior) directions [13].

There are four ACR CT phantom modules as shown in Figure 2(b). The first module is used to evaluate CT number accuracy as well as slice thickness, placement, and alignment. Low contrast resolution is assessed using Module2. A series of cylinders of various diameters (2, 3, 4, 5 and 6 mm) made up this image. The area between each cylinder equals to the cylinder's diameter, and the largest cylinder (25mm) is verifying the cylinder to background contrast level. Module3 is used for assessing the uniformity of CT numbers made up of uniform materials that are the same as tissue. Module 4 is used for evaluating the spatial (high contrast) resolution. There are eight bars in this section. Figure 3 shows the resolution patterns: 4, 5, 6, 7, 8, 9, 10, and 12 lp /cm with a15 mm x 15 mm square region



a) b)

Figure 2 (a). Picture of a properly positioned ACR phantom with axial (z-axis, cranial/caudal), coronal (y-axis, anterior /posterior), and sagittal (x-axis left/right) phantom centering. (b) Four ACR phantom modules showing scanner parameters.

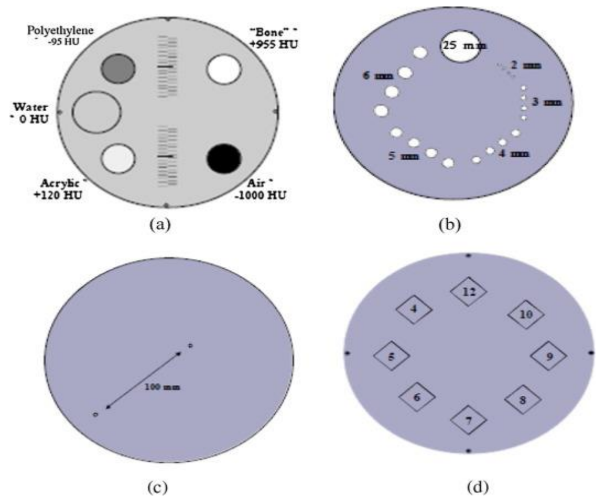


Figure 3. The five cylindrical rods

Water, bone, polyethylene, air, and acrylic are the five cylindrical rods shown in Figure 3(a) representing Module 1. (b) Cylindrical rods in various sizes representing Module 2. (c) Tissue-equivalent materials make up Module 3. (d) Module 4 expresses eight spatial frequency bar patterns.

3. Methods

The study was done in Urology and Nephrology Center, Mansoura University, Egypt. A three Modules of Philips

Phantom was scanned and four Modules of ACR phantom. The manufacture advanced quality assurance head axial protocol (64 x 0.625) was applied on both phantoms as shown in Table1.

3.1 Scanner instructions

The parameters were used from the instruction Manual for manufacture quality assurance phantom and applied for all the following tests. In another word: two phantoms were scanned on one CT-scanner at the same day using the same parameter settings (manufacture one).

Table 1 Philips phantom scan parameters for slice width (64 x 0.625) axial scan

head first/ supine		**120**	**Voltage [kV]**	**250**	**FOV[mm]**
240	MAs	0	Tilt	high resolution	Resolution
*	Length [mm]	n line	Recon.	4	No. of Slices
0	Center X[mm]	0	Increment [mm]	0	Center[mm]
64 x 0.625	Collimation	60	Window Center	0.625	Thickness
300	Window width	0.75	Rot. Time [sec]	E	Filter
360	Scan Angle	512	Matrix	1	Cycle time

3.2 manufacture Phantom and scanner alignment

Short tube conditioning was performed and a detailed Air calibration for all collimations was done in order to warm up the tube (at 120kv, STD). The system phantom used for slice width measurements was installed. Lateral survey. With the aid of a phantom holder the phantom was positioned on the table top. The phantom was then aligned in the axial, sagittal, and coronal planes at the gantry's center. The CT internal and external positioning lights of the laser were precisely located over the center section of the water phantom where the coronal light to up/down center of the phantom , the coronal light to up/down the center of the phantom.

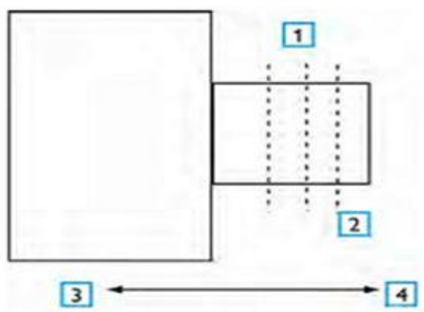


Figure 4. Example of axial scan on the survey. **1**: Head phantom, **2**: First slice, **3**: Out direction, **4**: In direction)

The axial light was directed to the phantom's middle and the sagittal light was directed to the phantom's left and right [14]. Furthermore, the gantry should be set to zero degrees.

3.2.1 Manufacture phantom tests

The four images which representing phantom tests were obtained as follow: planning an axial scan on the survey as shown in Figure4. Then standard patient scan was set up and the third head axial scan was performed using the parameters listed in Table 1.

3.2.1.a Positioning test and determination of slice thickness (width)

From module1: By capturing the first two scans on each side of the central (first scan), the phantom was shifted 20 mm in the in-direction to obtain the third scan. Directory window was accessed and the last slice of scan series was selected for measurement. The slice width icon was clicked. To symmetrically align the ROI on the aluminum strip and parallel to the plastic rectangles, it was moved, rotated, and resized. Both aluminum strips were measured. The results were averaged and verified if they were in tolerance range (1.1 mm +/- 0.50 mm).

3.2.1 b Determination of resolution

From module1 by placing the (head phantom's physics layer) in the middle of the scan circle. For easier positioning the laser marker was put on the first outer most circular engraving on the head section. The scan was performed using the impulse response head protocol. Resolution was changed from High to Standard. The scan resolution was analyzed using the Resolution Test application. The Resolution test which obtained by Full Width at Half Max should be within tolerance range: (1.45 +/- 0.1mm).

3.2.1.c Determination of uniformity, Noise (%error of linearity)

From module2 (water layer) the image noise was measured by calculating the standard deviation of the Hounsfield Units in a selected ROI which is centered within phantom image. Test results should meet tolerance (2.1 to 2.9). From Module 2 the uniformity test was obtained also by calculating mean CT values of ROIs drawn on the image. Results should meet tolerance (±7) HU.

3.2.1.d Determination of contrast scale and CT number

The head phantom's module3 (multi-pin layer) was set in the scan circle's center. For positioning assistance we put the laser marker on the third inner most circular engraving on the head section.

Contrast scale (low contrast detectability) is determined by applying a special algorithm to the CT values of all pixels in a ROI that is centered inside the phantom image. CT number was calibrated by comparing our measured readings of the different pins absorption with the tolerance shown in Table2, a small ROI was displayed inside each of the tested pins and regions for all measurements.

The line tool was used for verifying the contrast scale (high resolution) by calculating the diameter of a large Acrylic pin, result should be in tolerance (50±1mm). The capability of recognizing large acrylic pin rows.

After finishing our scans on Philips manufacture water phantom; it was removed and ACR phantom was just placed on the table. That keeps the same conditions of scanning.

3.3 Alignment of the ACR phantom and the scanner

The phantom was aligned in the coronal, sagittal, and transverse axis and CT scan plane on the axial axis. Phantom was centered on the table carefully and fixed well on the table because our scans will be done all in the same site [15].

3.3.1 Positioning test

This test was determined from Module 1 and Module 4. The table was adjusted until the alignment light was positioned over Module 1, and the direction of the land mark as well as the visibility of four BBs was calculated. Then we repositioned the table while the light was centered over module 4 the process was repeated. Results were obtained.

3.3.2 CT number calibration and slice thickness test

To determine the CT calibration the light was centered back to Module 1, and a circular ROI approximately 200mm the calculated mean CT numbers for each material. Results were matched with tolerances CT number values after each cylinder was placed as in Table 3. To calculate slice thickness: The number of visible wires in the top or bottom of the slice were counted and divided by two. Resulted value was recorded and compared with tolerance value (± 1.5mm).

3.3.3 Low contrast resolution determination

The alignment light was centered over Module2 after the table was shifted.

A ROI = 100 mm, WW = 100 mm, WL = 100 mm was used to obtain our image which at the center of the module. we hardly saw the 25 mm cylinder, couldn't recognize any other cylinders.

3.3.4 Noise determination test

The same Module2 was used for this test; one circular ROI of approximately 100 mm was placed over the large (25 mm) cylinder, while the other was placed outside the (25 mm) cylinder. The difference between the mean CT numbers of each ROI was calculated .Resulted value was divided by the Standard Deviation (SD) of the outside ROI. Resulted value represents the CNR (contrast to noise ratio) according to the formula:

$$CNR = (A-B)/SD$$

Where A: Is the mean CT number of ROI (on the 25mm cylinder). B: is the mean CT number of ROI (outside the 25mm cylinder). SD: is the standard deviation of the outside ROI.

3.3.5 Test for uniformity and plane distance

The table was moved to center the light over Module3. A ROI of approximately 400mm was used at the center of image and the four edge positions. WW approximately =100, WL approximately = 0.

The mean CT numbers for all five ROIs was recorded. The standard deviation of the center ROI was recorded. Then the uniformity value was calculated using formula= (center mean CT number – edge mean). Results should be in tolerance ±7 HU. Center CT number value must be within (±5 HU of the center ROI mean value). For evaluating the plane distance test; the distance between two BBs was measured and recorded.

3.3.6 Test for high contrast (spatial) resolution

The table was shifted to put the light over module 4 center. The eight bar patterns were checked carefully. The highest spatial frequency at which the bars and spaces were clearly visible was estimated and recorded. This image was filmed. The 4-lp/cm bar pattern was the simplest to be seen and the largest in its spaces and bars. The 12-lp/cm bar pattern was the most difficult to be seen.

3.4 Analyzing data

The image quality parameters obtained from the manufacture phantom were compared to the tolerance values of this phantom, and the image quality parameters obtained from the ACR phantom were compared to its tolerance values. Measures was manually obtained with DICOM viewer, DICOM was chosen because it was one of the non-commercial suitable images viewing software, also some measuring tools of Philips software were helpful.

4. Results

4.1 results of image quality tests using Philips phantom

4.1.1 Module 1

4.1.1.a Determination of slice thickness (width)

For module1: Both aluminum strips were measured and average the results .as shown in Figure 5 (1.66+1.67) mm/2 =1.66 mm. While nominal thickness set =0.625 mm. Difference between measured and set thickness =1.04 mm, tolerance (1.1 mm: 0.5mm). In this test we used automatic measuring tools of Philips software because manual DICOM couldn't perform this measurement.

4.1.1 b Determination of resolution

For the same module 1 (physics layer): As shown in Figure 5 the Full Width at Half Max were measured. Result equaled ١,٤٥ mm; while tolerance value is (1.45mm ± 0.1mm).

4.1.2 Module 2

4.1.2.a Determination of Noise

As shown in **Figure 6** noise was determined by Standard deviation of the selected CT number equaled 6.1 HU; while the tolerance which is (2.1 HU: 2.9 HU).

4.1.2 b Determination of uniformity

Uniformity was determined by measuring the mean CT number of each ROI as shown in Figure 7. Results were equal (7.8 , , 6.3 , 7.2 , 6.9 , 5.9)HU for the top , bottom , right , left and the center respectively. Science the tolerance values must be with in ±7 HU (according to ACR manual 2017[15&12]. There was a ring artifact appearing in this module clearly as shown in Figure [6 & 7].

4.1.3 Module 3

4.1.3.a Determination of CT number

Values were indicated as shown in Figure 8 and as in Table 2 for Nylon (Aculon), Acrylic, Lexan, Polyethylene, Teflon and water. Values were compared with the tolerance range.

4.1.3.b Determination of contrast scale

The contrast scale determination for the same module was by measuring the diameter of large acrylic pin. Result was equaled 51 mm while the value of diameter tolerance 50 ±1 mm. In the acrylic pin also there was a clear visibility of till row 2 which of diameter (1.25mm holes, 2.50mm apart). There was a center ring artifact clearly appearing in this module as shown in Figure 9.

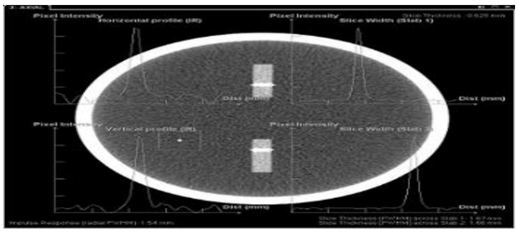


Figure 5. Module 1 Determination of slice thickness, resolution tests for Philips phantom)

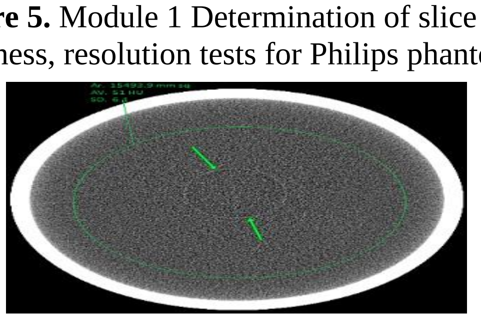


Figure 6. (Module 2 Determination of Noise for Philips phantom)

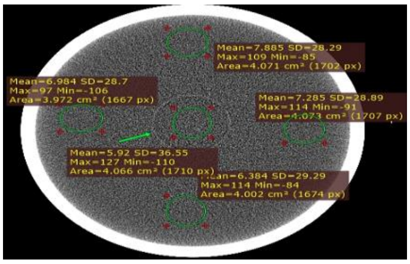


Figure 7. (module 2Determination of uniformity for Philips phantom)

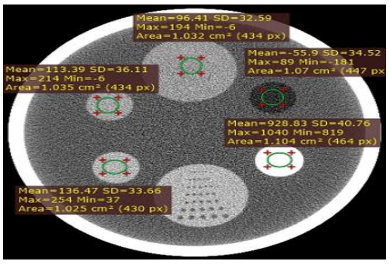


Figure 8. Module 3 Determination of CT number for Philips phantom

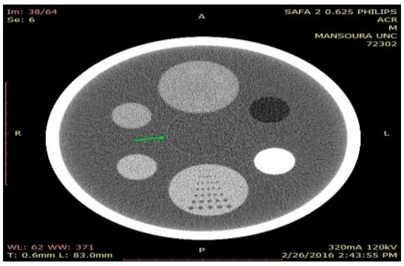


Figure 9. module 3 image shows appearance of ring artifact in determination of CT number test

Table 2. The CT numbers which resulted for various materials in the manufacture phantom.

Materials	Measured CT number (HU	SD (HU)	tolerance value	Results
Water	١,٥	٦,٧	0 ±4	pass
Nylon (Aculon)	96.41	32.9	+100 ± 15	pass
Polyethylene	-55.9	34.52	-75 ± 15	fail
Teflon	928.83	40.76	+1016 ± 50	fail
Acrylic	136.47	33.66	+140 ± 15	pass
Lexan	113.39	36.11	+116 ± 15	pass

4.2. Results of ACR phantom image quality tests

4.2.1 Module 1

4.2.1.a Calibration of the CT number and positioning

From module 1 and module 4: The visibility of three BB's was detected in module1. Central lines were visible as shown in Figure.10 (a, b).

4.2.1.b CT number accuracy

For certain ROIs the CT number was calculated and recorded. The results of the tests for water, polyethylene, bone, air, and acrylic were indicated in Figure.11 and Table.3. The resulted values were compared with tolerance values.

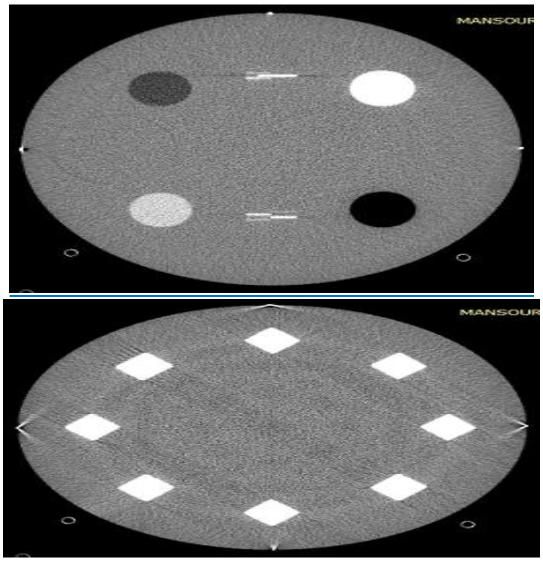


Figure10. (a) Module1alignmntand slice thickness tests for ACR phantom, **(b)** The alignment test n module4 for ACR phantom

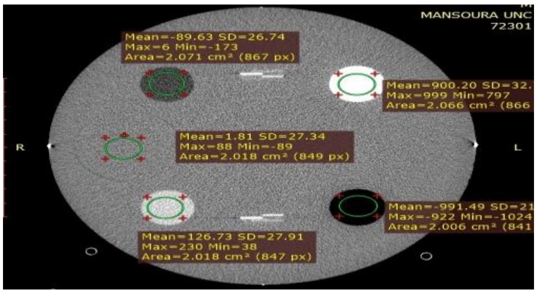


Figure 11. (module1 CT number test for ACR)

4.2.1.c Slice thickness determination

The slice thickness was determined as shown in Figure 10 (a) by dividing the one visible wire (in the top or the bottom) by two. Results equaled 0.5mm while the tolerance value equal ±1.5 mm.

Materials	measured CT number (HU)	SD (HU)	tolerance value	Results
Air	-991. 21		- 970: - 1005	pass
Acrylic	126.73	27.9	135: 110	pass
Bone	900.20	32.7	970: 850	pass
Polyethylene	-89.63	26.7	- 84: - 107	pass
Water	1.81	27.3	7: -7	pass

Table 3 In ACR, the table shows the measured results of CT numbers

Determination of low contrast resolution

It wasn't possible to recognize the groups and we hardly saw the large cylinder (25mm diameter) as shown in Figure.12. there was a ring artifact noticed in this module.

4.2.3 Module 3

4.2.3.a Noise determination

As shows in Figure.12, the (CT number outside of phantom - CT number inside the phantom) = (89.35 HU -100.43 HU) = 11HU. Resulted value was divided by the SD of the outside of phantom which equal 30.59 HU .So the calculated CNR= (11/3.59) = 0.3 while tolerance value is >1.

4.2.3.b Determination of uniformity

As shown in Figure 13, the obtained image uniformity was determined by calculating the mean CT number of the (top, bottom, left, right, and center). Then values of (center-edge) were calculated. Results equaled (6.1, 5.2, 5.5, 5.4) HU, the center value was equaled 6.7 HU. Results were compared with tolerance value which equal (±7 HU) as shown in Table 4. There was appearance of ring artifact close to the image edges in Figure 13.

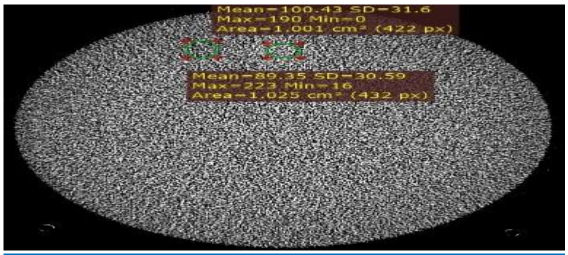


Figure 12 (module3 the test of noise for ACR)

4.2.3.c distance accuracy determination

The measured distance between two BB's Was 9.86 mm as shown in Figure 14 while tolerance value equals 2% ±100 mm. There was appearance of ring artifact close to the image edges in Figure 14.

4.2.4 Module 4

Determination of high-resolution test

Figure 15 represents the image we obtained. The line pairs groups from 4lp/cm to 7lp/cm were clearly seen and recognized. The four BB's in module4 were visible with appearance of strike artifact.

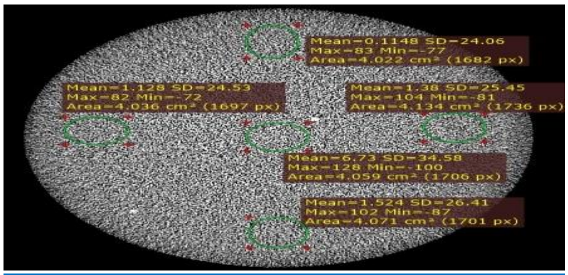


Figure 13 Module 3 uniformity test for ACR

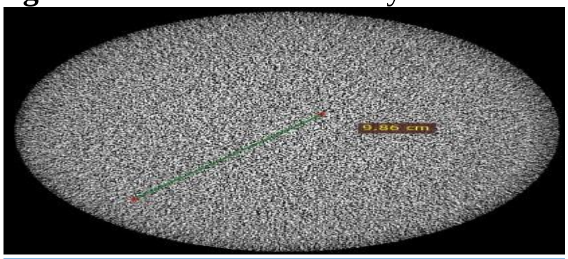


Figure 14 Module 3: distance accuracy test of ACR

Table 4: The uniformity test in ACR phantom

Position	measured CT number result (HU)	SD	Diff	Tolerance	
Center	6.7	34.5	6.7		Pass
Top	0.1	24	6.6		Pass
Right	1.3	25.4	5.4	± 7HU	Pass
Bottom	1.5	26.4	5.2		Pass
Left	1.1	24.5	5.6		Pass

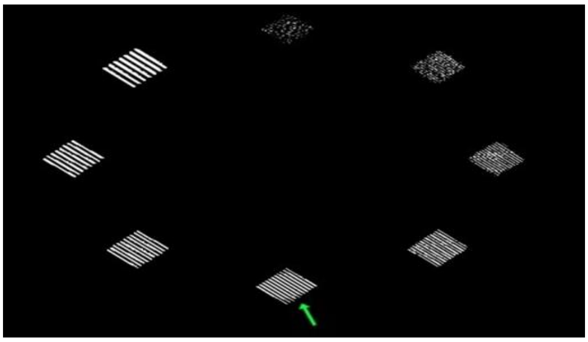


Figure 15 Module 4: high resolution test of ACR

5. Discussion

For PHILIPS phantom images, the slice thickness test was accepted in module 1 since it equaled 1.04 mm, which is within tolerance (1.1 mm: 0.5mm). For the same module the resolution test was accepted because it equaled 1.45mm, tolerance is (1.45mm ± 0.1mm). For module 2, the test of noise was failed because measured value equaled 6.1 HU; while the tolerance which is (2.1: 2.9 HU). For the same module the uniformity test was out of tolerance because results equal (7.8, 6.3, 7.2, 6.9, 5.9) HU for the (12,6,3,9 o'clock, center) positions respectively; while difference tolerance values with in ±7 HU according to ACR manual 2017[15]. There were two exceeded values (the top with deviation = 0.8HU & the right with deviation =0.2 HU). For module 3 the test of CT number values of Polyethylene, Teflon were exceeded tolerance with deviation = (4.1 HU, 37.1 HU) respectively; while values of Nylon (Aculon), Acrylic, Lexan, and water were accepted. For the same module the test of contrast scale and high resolution was accepted because the diameter of large acrylic pin equaled 51 mm which matches with the tolerance value 50 ± 1mm. we could recognize row 2 which of diameter (1.25mm holes, 2.50mm apart). For ACR phantom images: In module1 the alignment test was accepted because three BB's were visible and that matches with tolerance. For the same module the determination of slice thickness test was accepted because the result of measuring the one visible wire and divide it by two equaled 0.5m; while tolerance value is ±1.5mm according to Hobson et al [16]. The CT number accuracy test was accepted for the same module because all calculated CT number values were within the tolerance value rang and agrees with those of McCullough et al [1]. We needed to see the smallest low contrast group for module 2 but it wasn't possible to recognize it clearly so this test was out of tolerance. For the same module the determination of noise test was failed because the resulted CNR was 0.3, since the tolerance value >1, the noise determination test was out of tolerance. The uniformity test was performed on module 3: The mean CT number of the right, left, and bottom peripheral ROIs were largely similar while the top ROI was out of their values rang and the center ROI was slightly above the ACR tolerance of ±5 HU; while the resulted values of mean CT number of (center ROI - peripheral ROI) were in tolerance value which equal ± 7 HU and the test was accepted. The observed ring artifact in this module could be the reason which affected the center ROI uniformity. We also checked at this module the rest of the alignment test. The four BBs appeared, indicated that the test was passed. There was a strike artifact in this image. The high-resolution test was accepted for module 4 because the visibility tolerance value was 5lp/cm and the line pairs were possible to be seen up to 4lp/cm.

From all previous data analyzing and comparing the image quality parameters, which resulted in both phantoms, it was found that: Alignment, slice thickness, high contrast resolution, and uniformity tests were accepted in both phantoms; while noise test was out of tolerance in both phantoms as expected when applying high resolution protocols. Both phantoms were capable of recognizing artifacts. Two types of errors have been registered; a ring artifact and a strike artifact. Ring artifacts are very common and are generated by detectors of different sensitivities relative to each other. CT number test results were accepted in ACR phantom while the value of polyethylene CT number in Philips phantom wasn't meeting the tolerance. Low resolution test was out of tolerance in ACR but accepted in Philips. According to results and analysis we recommended a calibration process to be done by the biomedical engineer besides; recommending the ACR phantom as image quality assurance phantom for our tested scanner to achieve advanced quality checks of precise 0.6 mm slice thickness. ACR phantom is independent of manufacturers and providing the possibility to be used on different CT scanners and to compare the test results to one another. Beside that ACR has an internationally recognized status as a developer of standards and guidelines for radiology devices and quality assurance procedures.

Conclusion

To the best of knowledge, our study is the first of its kind in Egypt. This study is step on the way to upgrading the applications of image quality tests which have very important role in diagnosing head diseases and injuries. For better and accurate medical service we recommend image quality testing for all medical radiological scanners and spreading the awareness of image quality importance. Finally a qualified medical physicist should be provided for all radiology departments in Egypt to improve the image quality and monitor the radiation dose.

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